SUCTION PUMP FOR LIFTING EQUIPMENT

TECHNICAL FIELD

The present invention relates to a suction pump for lifting equipment.

More specifically, the present invention relates to a suction pump for lifting equipment for handling cardboard boxes, sheets of paper of fabric, cardboard or veneered wood panels, and flat laminates in general for which magnetic gripping devices cannot be used; to which application the following description refers purely by way of example.

BACKGROUND ART

As is known, all lifting devices for handling boxes, sheets, panels and flat laminates in general, be they bridge cranes or more sophisticated pneumatic handling devices, normally comprise a gripping device for firmly engaging the article to be lifted without damaging the surface of the article.

In the case of cardboard boxes, veneered wood panels, and plastic laminates in general, the gripping

device comprises a number of suction cups appropriately arranged on a supporting frame; and a suction pump connected by piping to the suction cups to draw the air out of the suction cups on command.

Obviously, the head and capacity of the suction pump depend on the physical characteristics of the article for handling. In the case of panels or plastic laminates with highly porous surfaces, for example, the suction pump must be capable of continuously drawing out all the air seeping into the suction cups through the uneven surfaces; failure to do so resulting in immediate release of the article.

Pneumatic gripping devices of the type described above are highly satisfactory in this regard, but, being forced to employ electric suction pumps, which are the only ones capable of meeting the specified performance requirements, have proved extremely hazardous in the event of electric power failure.

In the case of articles with highly porous surfaces, for example, air seepage into the suction cups is such that any interruption in electric power supply results in almost immediate release of the article by the gripping device, thus seriously endangering any operators in the area beneath or in the vicinity of the article when it is dropped.

Attempting to eliminate the drawback by connecting the electric motor of the suction pump to a

uninterruptible power supply unit is unfeasible, on account of the power rating of the electric motors in question being incompatible with commonly marketed uninterruptible power supply units: the electric power demand is so high as to rapidly discharge the buffer batteries of the uninterruptible power supply unit. Obviously, this could easily be solved by equipping the lifting device with a specially designed uninterruptible power supply unit, but the increase in cost would make the lifting device practically impossible to market.

To at least partly eliminate the risk of the article being released in the event of electric power failure, some manufacturers have therefore opted to fit the drive shaft of the electric motor with a flywheel to slow down stoppage of the electric motor in the event of electric power failure, and so keep the suction pump running long enough (a few tens of seconds) for the operators to clear the area and get out of harm's way.

The above solution obviously provides for a fairly limited margin of safety, which is also closely dependent on the structural characteristics of the article gripped by the gripping device. The flywheel also has the major drawback of greatly increasing start-up time of the suction pump following complete stoppage; which time may be incompatible with certain types of application involving frequent on-off operation of the suction pump.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a suction pump designed to eliminate the aforementioned drawbacks.

According to the present invention, there is provided a suction pump for lifting equipment, comprising an air intake device for drawing in air through an intake port, and an electric motor for rotating said air intake device; the suction pump being characterized by also comprising a pneumatic motor, and a mechanical connecting member for mechanically connecting the pneumatic motor to said air intake device to rotate the air intake device in place of the electric motor.

BRIEF DESCRIPTION OF THE DRAWINGS

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view of a suction pump for lifting equipment, in accordance with the teachings of the present invention;

Figure 2 shows a schematic view of a detail of the Figure 1 suction pump for lifting equipment.

BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Figure 1, number 1 indicates as a whole an electric suction pump, which may be used to particular advantage in pneumatic gripping devices of

lifting equipment.

Suction pump 1 comprises a centrifugal compressor 2 having an air intake 2a connectable in known manner to the suction cups of the pneumatic gripping device; a rotary electric motor 3 connected mechanically to centrifugal compressor 2 to rotate the movable part of centrifugal compressor 2 to draw in air through intake 2a; and a rotary pneumatic motor 4 connected mechanically to the drive shaft of electric motor 3 by a free-wheel connecting device 5 designed to rigidly connect the drive shaft of pneumatic motor 4 to the drive shaft of electric motor 3 only when the angular speed of the drive shaft of pneumatic motor 4 is greater than the angular speed of the drive shaft of electric motor 3.

In the example shown, as in most known suction pumps, centrifugal compressor 2 and electric motor 3 are coaxial with the same reference axis defining the longitudinal axis A of the pump.

More specifically, in the example shown, centrifugal compressor 2 substantially comprises an outer casing or volute 6 extending coaxially with longitudinal axis A of the pump and having two openings respectively defining intake 2a and the exhaust 2b of centrifugal compressor 2; and an impeller 7 mounted to rotate, inside a seat formed in outer casing or volute 6, about a barycentric axis of rotation coincident with

longitudinal axis A of outer casing or volute 6.

As stated, electric motor 3, which is preferably, though not necessarily, an asynchronous three-phase type, also extends coaxially with longitudinal axis A of the pump, and is connected to centrifugal compressor 2 so that its own outer casing 8 is fixed to the side of outer casing or volute 6 of centrifugal compressor 2, and so that the end of its own drive shaft 9 is fitted directly to the supporting shaft 10 of impeller 7 to rotate impeller 7 with no gear reducers or similar in between.

As regards pneumatic motor 4 and free-wheel connecting device 5, pneumatic motor 4, as shown in Figure 1, extends coaxially with longitudinal axis A of the pump, and is fixed to electric motor 3, on the opposite side to centrifugal compressor 2, by a number of connecting brackets 11 projecting, parallel to longitudinal axis A of the pump, from the cover of electric motor 3.

More specifically, pneumatic motor 4 is fixed to electric motor 3 with its own drive shaft 12 facing electric motor 3; and free-wheel connecting device 5 is located, coaxially with longitudinal axis A of the pump, between pneumatic motor 4 and electric motor 3, so as to rigidly connect drive shaft 12 of pneumatic motor 4 to drive shaft 9 of electric motor 3 when the angular speed of drive shaft 12 of pneumatic motor 4 is greater than

the angular speed of drive shaft 9 of electric motor 3.

Centrifugal compressor 2, electric motor 3, pneumatic motor 4, and free-wheel connecting device 5 are all commercial mechanical components which therefore require no further description.

With reference to Figures 1 and 2, suction pump 1 also comprises a pressurized-air storage tank 13; and an electropneumatic control circuit 14 for controlling electricity supply from the electric mains to electric motor 3, and pressurized-air supply from tank 13 to pneumatic motor 4 as a function of a number of external electric and pneumatic signals.

More specifically, with reference to Figure 2, as regards power supply to electric motor 3, electropneumatic control circuit 14 comprises an electric power line 15 electrically connecting electric motor 3 to the external electric mains (not shown); and a normally-open, electrically controlled power relay or electric switch 16, which is closed by an electric control signal to permit electric energy flow along electric power line 15.

As regards air supply to pneumatic motor 4, electropneumatic control circuit 14 comprises a main connecting pipe 17 for connecting tank 13 to pneumatic motor 4; a normally-closed, pneumatically controlled main on-off valve 18 located along main pipe 17, and which is opened by a pneumatic control signal to permit

pressurized-air flow along main pipe 17; and an auxiliary control pipe 19 having a first end branch-connected to main pipe 17, between tank 13 and main on-off valve 18, and a second end connected to the control terminal of main on-off valve 18 to supply main on-off valve 18 with the pneumatic signal controlling switching into the open position.

Electropneumatic control circuit 14 also comprises a normally-open, electrically controlled first auxiliary on-off valve 20 located along auxiliary pipe 19, and which is closed, to prevent pressurized-air flow to the control terminal of main on-off valve 18, by an electric control signal depending on the presence or not of voltage at the terminals of electric motor 3.

More specifically, in the example shown, the control terminal of auxiliary on-off valve 20 is connected electrically to the terminals of electric motor 3 by a cable 21, possibly with the interposition of a transformer, so that the electric signal controlling switching of auxiliary on-off valve 20 into the closed position is supplied by the external electric mains.

With reference to Figure 2, electropneumatic control circuit 14 also comprises a normally-closed, pneumatically controlled second auxiliary on-off valve 22 located along auxiliary pipe 19, between auxiliary on-off valve 20 and the control terminal of main on-off

valve 18, and which is opened by a pneumatic control signal to permit pressurized-air flow along auxiliary pipe 19.

With reference to Figure 2, electropneumatic control circuit 14 also comprises a known pneumo-electric transducer 23 (e.g. a pneumatically controlled electric switch), the output terminal of which is connected electrically to the drive terminal of power relay or electric switch 16 by a cable 24, so that the electric signal controlling switching of power relay or electric switch 16 into the closed position is defined by the electric signal generated by pneumo-electric transducer 23; and a control pipe 25 connected to the control panel (not shown) of suction pump 1, and which is filled in known manner with pressurized air, at a given pressure higher than atmospheric pressure, as long as suction pump 1 is to remain active, i.e. as long as electric motor 3 is to keep centrifugal compressor 2 running. The input terminal of pneumo-electric transducer 23 and the drive terminal of auxiliary on-off valve 22 are both connected to control pipe 25, so as to be activated when control pipe 25 is filled with pressurized air.

Operation of suction pump 1 is easily deducible from the foregoing description with no further explanation required, except for operation of electropneumatic control circuit 14.

In actual use, when suction pump 1 is turned on from the control panel (not shown), the operator pressurizes the air inside control pipe 25, which in turn switches auxiliary on-off valve 22 from the closed to the open position to permit pressurized-air flow along auxiliary pipe 19 to main on-off valve 18. At the same time, by means of pneumo-electric transducer 23, the pressurized air in control pipe 25 produces an electric signal, which is sent along cable 24 to the drive terminal of power relay or electric switch 16 to switch it from the open to the closed position and so permit electric energy flow along electric power line 15 to electric motor 3.

Obviously, connection of electric motor 3 to the external electric mains starts electric motor 3 and immediately switches auxiliary on-off valve 20 from the open position to the closed position preventing pressurized-air flow along auxiliary pipe 19 to the control terminal of main on-off valve 18, which therefore remains closed.

With the above configuration of electropneumatic control circuit 14, any electric power failure immediately switches auxiliary on-off valve 20 from the closed to the open position, so that the pressurized air in main pipe 17 reaches the control terminal of main on-off valve 18 (auxiliary on-off valve 22 is already open), and main on-off valve 18 switches from the closed

position to the open position permitting pressurized-air flow from tank 13 along main pipe 17 to pneumatic motor 4, which is thus started and runs electric motor 3 and centrifugal compressor 2 until all the air inside tank 13 is used up.

Suction pump 1 as described and illustrated herein obviously provides for considerable advantages as compared with conventional suction pumps, the most obvious being that of ensuring relatively prolonged operation in the event of power failure, thus enabling the operator not only to withdraw safely, but even to control the lifting device to lower the article safely to the ground before suction pump 1 cuts out. Operating time in the absence of electric energy, in fact, depends strictly on the capacity of tank 13.

Suction pump 1 also has the advantage of comprising currently marketed component parts of proven reliability, and which are far cheaper than any uninterruptible power supply unit.

Clearly, changes may be made to suction pump 1 as described and illustrated herein without, however, departing from the scope of the present invention.

For example, pneumatic motor 4 may be fixed to centrifugal compressor 2 on the opposite side to electric motor 3, and may be connected directly to supporting shaft 10 of impeller 7 by free-wheel connecting device 5. In which case, a second free-wheel

connecting device may be interposed between drive shaft 9 of electric motor 3 and supporting shaft 10 of impeller 7, so as to disconnect electric motor 3 when it is unable to run centrifugal compressor 2.

Centrifugal compressor 2 may obviously also be replaced by other rotary air intake and compression devices, such as lobed compressors, ducted fans, blowers and similar.